

Techniques Used for Optimizing 3D Geovisualization of Terezín Memorial

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** Terezín Memorial

Abstract. In memory of events happened in Terezín during World War II, the newly created Czechoslovak government, opened the Terezín Memorial in 1947. The key mission of the Memorial is to commemorate the victims of the Nazi political and racial persecution during the occupation of the Czech lands in WW II, to promote museum, research and educational activities, and look after the memorial sites connected with the suffering and death of dozens of thousands of victims of violence.

The largeness of Terezín Memorial and its interior complexity doesn't allow visitors to orient here without previous reading and studying. Moreover the sources that are available there is hard to understand. Therefore the project "Landscape of memory. Dresden and Terezín as places of memories on Shoah" aims to accentuate Terezín urban area for its history and Terezín Memorial for its depth of knowledge. The result of the project will be virtually presented landscape capturing the memories of the cross-border Czech-Saxony region in times of Third Reich. For this purpose the technologies serving for geographical description of historical contents, 3D visualization, data description and publication will be used, combined and further developed.

Keywords: 3D vizualization, bulk data, Shoah, Terezín

1. Historical Introduction to Terezín

Blodig (2003) is an excellent source for description of the history of Terezín. Therefore this book was used as a source for following introduction to the history of Terezín.

The first chapters in the history of Terezín began to be written at the end of the 18th century when Emperor Joseph II, acting on the experience of several previous Prussian-Austrian wars, decided about the construction of a fortress on the confluence of the Elbe and the Eger rivers. Its purpose was to prevent enemy troops from penetrating into the Bohemian hinterland along the road Dresden–Lovosice–Prague and also protect the waterway along the river Elbe. Built within a decade, the fortress consisted of the Main and Small Fortress, as well as a fortified area between the Old and New Eger. The fortifications consisted of a number of different elements – massive bastions, ravelins, lunettes, ramparts, bulwarks, floodable moats and a large network of underground corridors. The hollows, which covered two thirds of the perimeter of the fortress, could also be flooded. However, the fortress and its fortifications had never been used in war operations, and the whole structure, at the time of its opening virtually impregnable, gradually fell out of use. Eventually, the fortress was abolished and Terezín became a garrison town. But already in the 19th century the prison situated in the Small Fortress grew to be ill famed, serving this purpose also in the first half of the 20th century. Many enemies of the Habsburg monarchy, including the Sarajevo assassins, were jailed in the prison during World War I; following the establishment of the Czechoslovak Republic in 1918 it housed a military prison and penitentiary for another 20 years.

Terezín earned its international notoriety in the years of the World War II; since its end it has been one of the symbols of the persecution of the political opponents of Hitlerite Germany and of the heinous Nazi program of the genocide of European Jewry.

Back in June 1940 the Small Fortress in Terezín was turned into the Prague Gestapo Police Prison where mostly political prisoners were incarcerated. Thousands of members of different groups of the anti-Nazi resistance movements from the occupied Czech lands as well as inmates from many other countries passed through the prison.

The town itself – former Main Fortress – was turned in November 1941 into a ghetto, an internment and transit camp for the Jews. Deported to the ghetto were Jews from the then Protectorate of Bohemia and Moravia, later also from Germany, Austria and other countries.

A branch of the Flossenbürg concentration camp was established in nearby Litoměřice in the spring of 1944. The local inmates first had to build underground factories and then work there as slave labourers for the Nazi war-time industrial production.

Between 1940 and 1945 more than 200,000 people from three dozens of countries were imprisoned in the three repressive facilities. One in five in-

mates died in either of the repressive facilities, nearly 90,000 prisoners perished after their deportation to other places of suffering. They died in extermination and concentration camps, in penitentiaries, prisons and mass execution grounds.

But not even the nearing end of the war spelt an end to suffering and mass deaths in Terezín and Litoměřice. At the turn of April and May 1945, evacuation transports as well as death marches brought into the Terezín Ghetto further more than fifteen thousands of inmates from the concentration camps being vacated before the approaching front, and with them typhus and other infectious diseases. As a result, not only the just liberated prisoners but also physicians and other medical personnel from the ranks of the former inmates, members of the Czech Action for Help – volunteers from Prague and other places as well as Red Army medical staff kept dying weeks after the war ended. Thanks to the enormous efforts as well as sacrifices made by the physicians and other medical staff, the typhus epidemic had eventually been stopped, and some 25,000 people were saved from death. It was then possible, between May and mid-August 1945, to repatriate all the former inmates.

At the initiative of the government of the restored Czechoslovak Republic the Memorial of National Suffering, later renamed to Terezín Memorial, was established in the places of wartime suffering of dozens of thousands of people in 1947. The key mission of the Memorial was to commemorate the victims of the reign of violence in the years of World War II and to look after the sites connected with their suffering as well as their heroism. This is duly reflected in the Terezín Memorial's museological, research, documentation, collection, and educational activities. After all, today as well as in the future it is essential to recall the crimes committed in the past and to warn against everything that jeopardizes freedom, democracy, human rights and tolerance in relations among people anywhere in the world.

2. GEPAM – project focused of memories on Shoah

As was mentioned above, the project “Landscape of memory. Dresden and Terezín as places of memories on Shoah” aims to accentuate both Dresden and Terezín urban areas for its history, where the Czech part of the project focuses on Terezín Memorial for its depth of knowledge. The project consortium consists of:

- Technische Universität Dresden, MitteleuropaZentrum für Staats-, Wirtschafts- und Kulturwissenschaften (lead partner),
- Terezín Memorial,

- University of West Bohemia, Geomatics section at Faculty of Applied Sciences.

TU Dresden as the lead partner coordinates the project activities and together with University of West Bohemia is involved in the development and determination of a conception, techniques and technologies for creation of 3D models based on various sources and old maps. The partner Terezín Memorial has the main historical and background knowledge that is crucial to ensure the creation of a realistic 3D model with necessary descriptive lexical information. This information will help visitors to answer the questions like how the buildings looked in the past or receive available information about their relatives.

3. Sources of Information for 3D model

When work on 3D geovizualization began, it was necessary to search available materials and select only those that can be used for 3D modeling of selected objects. All original documents were mostly stored in the following institutions:

- Terezín Memorial (<http://www.pamatnik-terezin.cz>),
- State Regional Archive in Litoměřice (<http://www.soalitomerice.cz/en>),
- Austrian State Archive in Vienna – Military Archive (<http://www.oesta.gv.at>),
- Military Historical Archive in Prague as a department of Military Central Archive in Prague (<http://www.vuapraha.cz/Pages/VojenskyHistorickyArchiv.aspx>),

Overall, we had more than 2500 files (digital scans, photos, etc.) from Military Historical Archive as a department of Military Central Archive in Prague. For 3D modelling were used plans of fortifications, buildings, facades and reconstruction plans of buildings. The interior equipment building plans were used only sporadically, e.g. for 3D modelling of important buildings such as the Church (in Czech called Kostel Vzkříšení Páně, next in the text only Church).

For modelling of buildings we used most ground plans (see *Figure 1*) and facade plans (see *Figure 2*). For modelling of roofs and interiors we used plans (profiles) of buildings (see *Figure 3*). Plans and drawings of individual parts of the church (see *Figure 4*), such as windows, cornices, staircases, decor etc. were very important for modeling of facade details. The above described materials are available for fortification as well as for individual buildings. If necessary, also the maps and plans of (Austrian State Ar-

chive....) and (State Regional Archive in Litoměřice...) will be used for modelling of buildings.

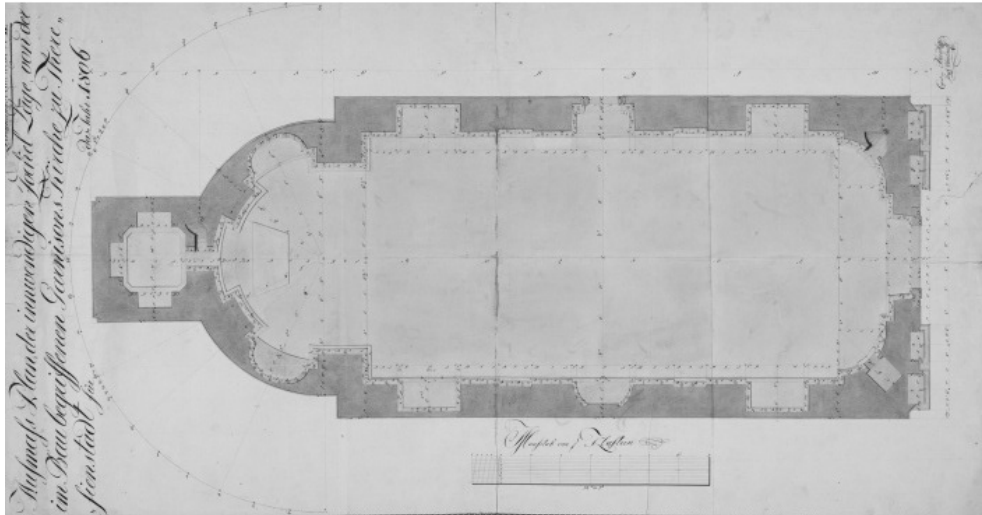


Figure 1. The ground plan of the Church in Terezín (Military Historical Archive... 1780 – 1943, sign. 1-25/a1/631900).

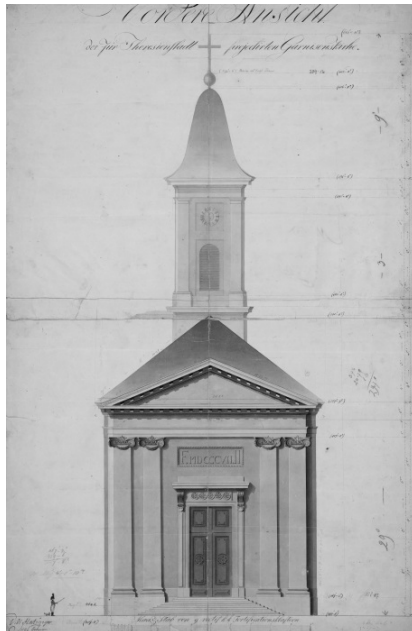


Figure 2. View of the entrance portal and the tower of the church in Terezín (Military Historical Archive... 1780 – 1943, sign. 1-25/a4/632300, 1-25/a4/632600).



Figure 3. Plan of the city Church in Terezín (Military Historical Archive... 1780 – 1943, sign. 1-25/a4/632500).

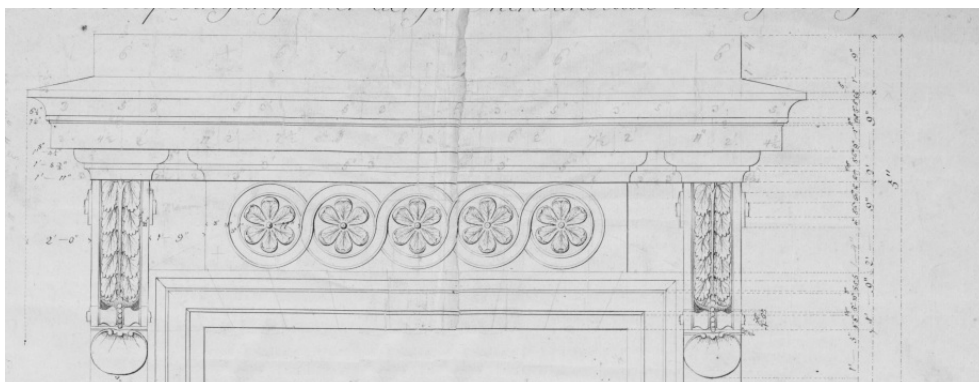


Figure 4. Details over the entrance portal of the church in Terezín with sizes in Viennese fathoms (Military Historical Archive... 1780 – 1943, sign. 2517/n38/672200).

These plans are occasionally in metric rate, more frequently in fathom rate. Even after a calculated conversion between these rates, a lot of proportions didn't fit to the real proportions of the buildings derived from the Technical map of the city, which was geodetically surveyed. It was presumably caused by disproportion between the plan and real construction. In this case, the proportions from the old plans and profiles of the buildings were transformed to the real proportions. This could have been done because the proportions of the standing building were not changed since the World War II.

The plans of the city fortification are very detailed because of its historical importance. However, dealing with the detailed plans of the fortification and modeling of the fortification based on the plans is not appropriate for the project that focuses mainly on World War II history of the city. Because of the complexity of the plans and a simple geometry of the fortification it has been decided that the main source of spatial information on fortification will be a stereo photogrammetric measurements on current aerial images.

4. Concept of the Terezín model

Looking at the concept of the virtual model of Terezín Memorial, the model consists of two main parts: the geometric 3D model which depicts the place and the lexical base of data which describes the history of Terezín, mainly during the WW II.

Taking a closer look, the heterogeneous nature of existing both analogue and digital documents about the history leads to use a content management system (CMS). CMS is used, together with a relational database, for the lexical data. Each document in CMS has its unique identifier, identifier of a place to which is referred to and two dates referring to a time period. The spatial part of the Terezín model consists of detailed models of all historically valuable buildings and constructions. These models are complemented with less detailed models of the rest of buildings and constructions in the Terezín town.

Both lexical and spatial part of the virtual model is filled up with large amount of data. Therefore it is crucial to build such a method of (both lexical and spatial) data selection, which is fast and serve relevant information to the user. Whereas well known one dimensional data indexes can be used for lexical data, situation is a bit more complex in 3D, where common geographic (two dimensional) data indexes cannot be used. In 3D, size of bounding box (BB) of each potentially portrayed object is calculated, based on the observer position, its view direction and the distance from the object. When the size of BB of each object is calculated, different level of detail

(LOD) of each object can be displayed. Different LODs are used also in two dimensional maps, where they are used for creation of a scale dependent map, but there is again principal difference between 2D and 3D. While in 2D always just one LOD at a time is portrayed in the map, objects closer to the observer are displayed in higher detail then farther ones in 3D. It leads to a situation, where objects are displayed in different LODs in one 3D scene. This issue poses a major challenge to a creation of a multi-scale 3D model, because different LODs have to share major shape (at least footprints and heights). Moreover the virtual model has to be also time aware, therefore each piece of information in the database has to have a time period for which it is valid.

5. Technical solution

At the beginning of the project a tool for creating models of buildings in Terezin was sought. The first choice was using a GIS for creating the footprints of buildings (LOD 0) and then import these footprints into graphical modeling program (CAD program) and create the rest of the level of details via this program, because working with 3D models of buildings in CAD programs is far more user-friendly then in GISs. The main idea of using GIS was about having data defined in geographic coordinate system. But this way turned out inappropriate, mainly because the proportions of footprints were defined as float number (for instance the length of 40 meters was stored as 39,99995; ArcGIS 10.1 was used as a chosen GIS). This led to the situation where in a long-distance view at the data, the edges of footprints were supposed to be parallel, but they were not. The second reason for not using GIS were in-build tools for ease modeling of 3D objects in GIS, which are not sophisticated and are not intuitive for a user.

On the base of mentioned information it has been decided, that the optimal way for creating footprints of building will be through the graphical program for modeling 3D objects. It has three main advantages beside the GISs. The first is, the program does not change integer length to float. The second is ease and intuitive work with drawing tools in such a program. The third is that there is no need for data conversion during creation of different LODs. The Trimble SketchUP (abbreviated as SU) was chosen as a tool for modeling 3D buildings in Terezin, through all level of details, because it fulfilled all three previous advantages. For more information about creating models in SU, see e.g. Chopra (2011).

Since the beginning of this project it has been known that there will be a huge amount of spatial data. Therefore it has been decided using a concept of LOD based on LOD in CityGML standard (OGC(2012)). This concept is

made for lowering severity of 3D visualization of objects, which are stored in a spatial database. The principle consists of division of objects into successive component parts. They share the shape of the footprint and the height of the building. It also enables an analysis and visualization of the same object depending on different desired LOD.

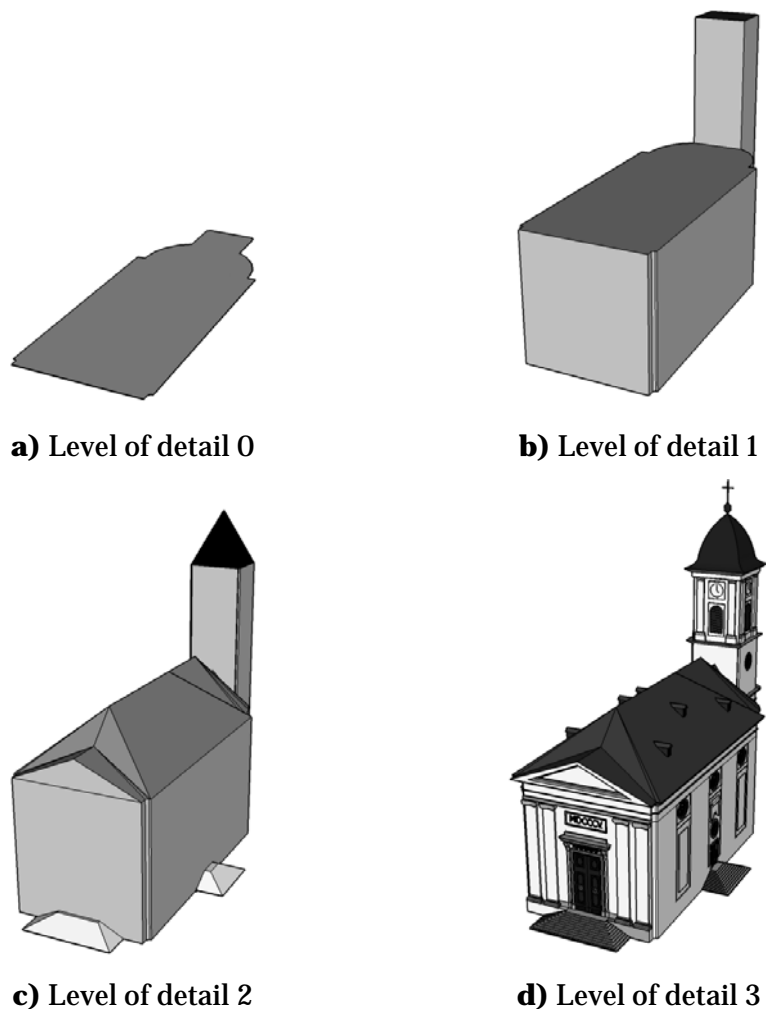


Figure 5. Levels of details shown on example of city church.

As an example for showing how the LOD concept works, the church of Resurrection in Terezín was chosen. First step was a creation of a footprint of this church (*Figure 5a*). This corresponds to the level of information about the object (LOD0). Next step is a block representation of the object. It is

built on the footprint of the church and the block representing the church has two height specified parts. The first is the church's nave, the second is the tower of the church (see *Figure 5b*). This represents a prismatic shape of the building (LOD1). Following step is creation of roof-shaped structures and thematically differentiated boundary surfaces on the exterior shell (see *Figure 5c*). This representation recalls the building itself (LOD2). Penultimate level of detail consists of architectural models with detailed wall and roof structures (see *Figure 5d*). With this level of detail the exterior of the building is fully (depending on intended accuracy of the model) modeled (LOD3). In the last level of detail the interior of the building is included into model. This is the most detailed form of the model (LOD4). For the purposes of Terezín Memorial, LOD4 is not necessary, thus it is not shown among the LOD's examples.

The visualization of the Terezín 3D model uses separate storage of each particular LOD of the model is suitable for fast visualization. Each level is stored directly in a spatial database and just appropriate LOD is send to the client for visualization - therefore no generalization techniques or loading of huge volume data is necessary. This type of visualization is so called view-dependent visualization. It is based on the position and view-direction of the observer while the objects closer to the observer are visualized more detailed than the distant objects.

The Terezín Memorial manages information related to buildings, places and people in Terezín, even these pieces of information are not referenced to all buildings or places in the town. Therefore two categories of buildings and places were established – based on the importance of the building or place during WW II. Division to important and not important buildings led to different way of modeling of these two categories of buildings in LOD3. Much more detailed LOD3 visualization was used for important buildings.

To deal with a high complexity of the Terezín Memorial model, a KML built-in features (see OGC (2008) or Wernecke (2009)) are used for LOD switching. It is based on size of a bounding box that is calculated by viewer for each building. A suitable LOD is selected for displaying according to the size of the bounding box and limits embedded in the model.

Other possibility, based on on-the-fly generation of a model according to actual view, is also considered for use with viewers that does not support features necessary for self-actuated LOD switching. This approach is of course more resource consuming since a new model must be generated after each change of view. To minimise these shortcoming, the model contains just references (links) to selected LOD submodels of objects, like a

table of contents, so that only applicable LOD submodels must be treated by the viewer.

A standalone paper could be written about the time dimension of the model as the virtual model has to be also time aware. Therefore each piece of information in the database has to have a time period for which it is valid. This is the current and near future aspect of the Terezín geovisualization with which the project consortium deals nowadays.

6. Summary

In summary, the paper introduces history of Terezín as important reminder of events happened there during the WW II. Consequently it describes a motivation of the project and then presents and explains the concept used for model creation. The paper also describes the used technical solution in detail. The result of the project is an interactive information system displaying 3D models of Terezín Memorial containing the multimedia historical content. The model will be available at Memorial's premises and installed on kiosks. Alternatively the model will be available for presentation on the web.

Realization of the project increases understanding of a common history, especially for a historical tragedy Shoah, which will become a mutual heritage and obligation for the future. The project initiates and intensifies a relationship between project partners.

7. Acknowledgement

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